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Effect of various media on seed germination, seedling growth and establishment of annual drumstick (*Moringa oleifera)* cv. PKM 1

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Abstract
The present experiment was conducted to study the effect of various media on seed germination, seedling growth and establishment of drumstick **(***Moringa oliefera)* cv. PKM 1 from July to October at the department of Horticulture, SHUATS, Prayagraj, India. The experiment was conducted in a Randomized Block Design (RBD) with twelve treatments combinations and one control with three replications using vermicompost, poultry manure, goat manure, FYM, sand and soil to find out the best media combination for the growth and development of drumstick plant. The growth parameters such as stem height, stem girth and no. of leaves were recorded at 30,60and 90 days after germination. The physiological parameters and quality parameters such as fresh weight of shoot (g), fresh weight of root(g), total plant weight, root: shoot ratio, moisture, ash, fat and fiber content were analyse at 90 days after germination. It was concluded that application of media combinations T_{11} [Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Poultry Manure (20%)] records the maximum germination percentage, stem height, stem girth, fresh weight of shoot and fresh weight of root. This media combination also records the maximum ash and fiber content.

Keywords: *Moringa oleifera*, sand, soil, vermicompost, farmyard manure, poultry manure, goat manure

Introduction
Moringa oleifera belonging to the family Moringaceae is a handsome softwood tree, native of India, occurring wild in the sub Himalayan regions of Northern India and now grown worldwide in the tropics and sub-tropics. In India it is grown all over the subcontinent for its tender pods and also for its leaves and flowers. The genus Moringa includes 13 species distributed in sub-Himalayan ranges of India, Sri Lanka, North Eastern and South Western Africa, Madagascar and Arabia. The best known and most widely distributed species is Moringa pterygosperma Gaerthn (syn. *Moringa oleifera Lam*). *Moringa oleifera* is most widely cultivated because of its high nutritional, medicinal, agricultural, domestic and environmental purposes. It is the most common species cultivated throughout the tropics, fast growing and not very demanding with regard to climate and soil quality (Muluvi *et al.,* 1999) [9]. M. oleifera is known by several common names, usually dependent on the country and tribe but in English it is commonly referred to as "Horseradish tree" (due to the flavour of its root), "Drumstick tree", "Never Die tree", "West Indian Ben tree", or "Radish tree".
The soil is generally used as a basic medium because it is cheapest and easy to procure supplementing of the soil which is aimed to make media more porous while the organic matter (Vermicompost, poultry manure, FYM) is added so as to enrich adequate nutrients for the seedlings. A growing medium is a substance through which roots grow to extract water and nutrients. The growing medium also plays an important role in seed germination not only it does act as a support, but also a source of key nutrients for plant growth.

Materials and Methods
The research work was carried out during 2018-2019 at the research farm of Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (U.P.). The climate in Prayagraj, UP, has been classified as semi-arid with both the extent of temperature during winter and summer. During December to January, the temperature may drop down to as low as 2 ˚C, while it may exceed to 47 ˚C during May- June. Frost during winter and hot air during summer are common occurrences.

It comes under subtropical climate receiving the mean annual rainfall of about 1100mm, major rainfall from July to end of September. However, occasional precipitation was also not uncommon during winter. The winter months were cold while summer months were very hot and dry. The experiment was conducted in a Randomized Block Design (RBD) with twelve treatments combinations and one control. Treatments consisted of T_0 -[Soil (75%) + Sand (25 %)], T_1-[Soil (25%) + Sand (25%) + FYM (50%)], T_2-[Soil (25%) + Sand (25%) + Poultry Manure (50%)], T_3-[Soil (25%) + Sand (25%) + Vermicompost (50%)],T_4-[Soil (25%) + Sand (25%) + Goat Manure (50%)], T_5-[Soil (25%) + Sand (25%) + FYM (25%) + Vermicompost (25%)], T_6-[Soil (25%) + Sand (25%) + FYM (25%) + Poultry Manure (25%)],T_7-[Soil (25%) + Sand (25%) + FYM (25%) + Goat Manure (25%)] T_8[Soil (25%) + Sand (25%) + Vermicompost (25%) + Poultry Manure (25%)]-,T_9[Soil (25%) + Sand (25%) + Goat Manure (25%) + Poultry Manure (25%)]-, T_{10}-[Soil (25%) + Sand (25%) + Goat Manure (25%) + Vermicompost (25%)], T_{11}-[Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Poultry Manure (20%)], T_{12}[Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Goat Manure (20%)]. The plant height was determine using a meter rule, the stem girth using a vernier calliper while the number of leaves by counting. The ash content was determined using the method described in Association of analytical chemist (AOAC, 1995) [2]. The moisture content of the samples was determined using Association of analytical chemist method. Fat was determined using soxhlet fat extraction method. Crude Fibre content was determined by Weende's method.

Results and discussion

Germination percentage recorded at the end of the study of the various soil treatments combinations is shown in table 1.T_{11}- Soil + Sand + FYM+ Vermicompost+ Poultry Manure at 1:1:1:1:1 shows the highest germination while the lowest percentage is obtained with T_0 i.e. control. The germination percentage recorded was high for all treatment combinations which could be a result of the pre-seeding treatment of the seeds before sowing. According to Fuglie (2000) [5], pre-seeding treatment method of Moringa seeds such as soaking in water, cracking shells of seeds, or removing shells of seeds and planting the kernel only would enhance germination greatly. The germination percentage result indicates that the treatment combination T_{11} recorded the highest germination percentage value. According to Balasubramaniyan and Palaniapan (2004) [3], poultry manure has higher percentage of phosphorus, Panda (2005) [10] farmyard manure and vermicompost contains organic matter and thus enhanced good drainage and facilitates aeration. Therefore a combination of these manures might have accounted for T_{11} [Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Poultry Manure (20%)] recording the highest germination percentage in moringa seedlings.

The use of different growing media showed a significant difference ($p<0.05$) at 30, 60 and 90 days after germination in stem height and stem girth. At 90 days after germination T_{11} recorded the highest stem height (136cm) and stem girth (2.03mm).The higher number of plant height and plant girth may be due to the fact that poultry manure mineralization is rapid and with the combination of farm yard manure and vermicompost which facilitates drainage, aeration and contains nutrients which to further add to the rapid growth and development of the plant. Vermicompost also influences the rapid growth of beneficial microorganisms and increases the nitrogenase and enzymes activity (Gopalreddy, 1997) [6]

The use of various media combinations showed significant difference ($p<0.05$) at 30, 60 and 90 days after germination in number of leaves per plant. At 90 days after germination T_5-[Soil (25%) + Sand (25%) + FYM (25%) + Vermicompost (25%)] recorded the highest number of leaves (380) whereas control recorded the least number of leaves (254). This result confirms the findings by Swiader *et al*. (1992) [12] that the best soil for growing vegetables is one that is well drained, fairly deep and has a relatively high amount of organic matter.

Soil media differed significantly ($p<0.05$) in fresh weight of seedlings at 90 days after germinations shown in table 2. Soil mediaT_{11}recorded the highest value at 90 days after germination whereas control recorded the least values (Table 5). The highest mean fresh weight recorded at 90 days after germination T_{11} [Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Poultry Manure (20%)] may be due to the fact that vermicompost has relatively higher amount of organic matter (Gopalreddy, 1997) [6] Also, Compost and farm yard manure are good substitute of other organic matter and thus its effect on vegetable is similar to that of pure manure (Sinnadurai, 1992) [11]. It is capable of improving soil structure and soil tilth in addition to the supply of plant nutrients.

The quality analysis on the leaves of drumstick harvested at 90 days after germination is shown in table 2. The Fat and moisture shoes no significant difference at 90 days after germination while ash and fibre recorded to have significant difference at 90 days after germination. The ash content of *Moringa oleifera* leaves from all the treatment combinations were higher than (6.00%) reported by (Sodamade, 2013) [13] but lower than (7.93%) as reported by (Anthonia, 2002) [1]. The highest % moisture obtained from control plant is lower than (9.00%) as reported by (Sodamade, 2003) [13]. Crude fat value of *Moringa oleifera* leaves (2.53%) from control plant was higher than 0.5% reported by Mansah *et al.*, (2012) [8]. The value of fiber obtained from Moringa oleifera leaf (8.9%) from treatment combinations T_{11} higher than 9.25% and 3.5% as reported by (Iboke*t et al*., 2008) [7] and (Elkhalifa *et al.*,2007) [4] respectively.

Table 1: Effect of media on the germination %, stem height, stems girth and number of leaves of **Moringa oleifera** cv. PKM 1

Treatment No.	Treatments combinations	Germination %	Stem Height (cm)			Stem Girth (mm)			No. of leaves		
			30 DAG	60 DAG	90 DAG	30 DAG	60 DAG	90 DAG	30 DAG	60 DAG	90 DAG
T_0	[Soil (75%) + Sand (25 %)]	79	36.0	79.0	101.33	0.69	0.82	1.43	58.66	223.33	254.33
T_1	[Soil (25%) + Sand (25%) + FYM (50%)]	80	39.3	80.6	120.22	0.74	0.90	1.54	60.33	277.33	306.33
T_2	Soil (25%) + Sand (25%) + Poultry Manure (50%)]	82	39.0	83.6	134.66	0.68	0.85	1.53	71.33	265.66	296.33
T_3	[Soil (25%) + Sand (25%) + Vermicompost (50%)]	82	38.0	82.3	128.33	0.65	0.88	1.57	68.66	256.33	351.66
T_4	[Soil (25%) + Sand (25%) + Goat Manure (50%)]	83	38.3	82.6	131.66	0.64	0.83	1.54	70.33	273.00	292.00

T_5	[Soil (25%) + Sand (25%) + FYM (25%) + Vermicompost (25%)]	83	37.6	84.0	130.66	0.72	0.85	1.53	75.00	303.33	380.00
T_6	[Soil (25%) + Sand (25%) + FYM (25%) + Vermicompost (25%)]	83	40.3	81.6	133.66	0.67	0.80	1.56	71.66	277.00	295.00
T_7	[Soil (25%) + Sand (25%) + FYM (25%) + Goat Manure (25%)]	83	38.3	83.3	131.00	0.66	0.82	1.58	71.00	273.33	322.00
T_8	[Soil (25%) + Sand (25%) + Vermicompost (25%) + Poultry Manure (25%)]	82	39.6	86.0	135.00	0.67	0.89	1.52	72.33	281.33	323.33
T_9	[Soil (25%) + Sand (25%) + Goat Manure (25%) + Poultry Manure (25%)]	80	41.3	81.0	131.66	0.80	0.86	1.58	72.00	268.00	291.66
T_{10}	[Soil (25%) + Sand (25%) + Goat Manure (25%) + Vermicompost (25%)]	81	41.6	81.3	134.00	0.74	0.90	1.70	73.66	286.33	313.00
T_{11}	[Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Poultry Manure (20%)]	85	42.6	84.3	136.00	0.72	1.26	2.03	74.33	286.66	361.33
T_{12}	[Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Goat Manure (20%)]	83	40.3	82.6	130.00	0.75	1.08	1.76	73.00	278.00	324.66
	F-test	S	S	S	S	NS	S	S	S	S	S
	C.D. at 0.5%	2.48	2.67	3.72	10.58	0.06	0.30	0.292	8.32	31.72	48.31
	S.Ed. (±)	1.24	1.32	1.86	5.29	0.03	0.15	0.146	4.16	15.86	24.15

Table 2: Effect of media on the fresh weight of shoot, fresh weight of root, total weight of plant, root: shoot ratio, ash, moisture, fat and fiber contents in *Moringa oleifera* cv. PKM 1

Treatment No.	Treatment Combinations	Fresh weight of shoot (g)	Fresh weight of root(g)	Total weight of plant (g)	Root: shoot ratio	Ash	Fat	Moisture	Fibre
T_0	[Soil (75%) + Sand (25 %)]	12.66	6.21	18.87	0.49	5.53	2.53	6.00	6.16
T_1	[Soil (25%) + Sand (25%) + FYM (50%)]	15.00	6.75	21.75	0.45	6.00	1.90	5.57	7.30
T_2	[Soil (25%) + Sand (25%) + Poultry Manure (50%)]	15.46	6.60	22.06	0.42	6.40	1.93	5.82	7.23
T_3	[Soil (25%) + Sand (25%) + Vermicompost (50%)]	15.23	6.81	22.04	0.44	6.06	2.16	5.67	7.36
T_4	[Soil (25%) + Sand (25%) + Goat Manure (50%)]	16.30	6.40	22.70	0.39	6.48	2.26	5.85	7.23
T_5	[Soil (25%) + Sand (25%) + FYM (25%) + Vermicompost (25%)]	16.33	7.63	23.93	0.46	6.41	2.00	5.56	7.60
T_6	[Soil (25%) + Sand (25%) + FYM (25%) + Vermicompost (25%)]	15.33	7.41	22.74	0.48	6.50	2.11	5.66	8.16
T_7	[Soil (25%) + Sand (25%) + FYM (25%) + Goat Manure (25%)]	17.33	7.12	24.45	0.41	6.74	2.40	6.03	8.06
T_8	[Soil (25%) + Sand (25%) + Vermicompost (25%) + Poultry Manure (25%)]	18.00	7.13	25.13	0.39	6.66	2.34	5.78	8.26
T_9	[Soil (25%) + Sand (25%) + Goat Manure (25%) + Poultry Manure (25%)]	16.00	7.13	23.13	0.44	7.16	2.07	5.83	8.80
T_{10}	[Soil (25%) + Sand (25%) + Goat Manure (25%) + Vermicompost (25%)]	20.00	7.44	27.44	0.37	7.03	1.84	5.76	8.56
T_{11}	[Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Poultry Manure (20%)]	21.33	8.54	39.87	0.40	7.50	2.21	5.80	8.96
T_{12}	[Soil (20%) + Sand (20%) + FYM (20%) + Vermicompost (20%) + Goat Manure (20%)]	20.33	8.16	29.49	0.40	7.10	1.94	5.71	8.70
	F-test	S	S	S	S	S	NS	NS	S
	C.D. at 0.5%	2.15	0.56	2.10	0.03	0.539	0.418	0.284	0.734
	S.Ed. (±)	1.07	0.28	1.05	0.01	0.269	0.202	0.142	0.367

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